



**STATE OF TENNESSEE
DEPARTMENT OF ENVIRONMENT AND CONSERVATION
DIVISION OF UNDERGROUND STORAGE TANKS**

TECHNICAL GUIDANCE DOCUMENT - 008

**Effective Date - January 13, 1992
Revised Date - November 19, 1993
Revised Date - August 1, 1996
Revised Date – July 1, 2002***

RE: Exposure Assessment

PURPOSE AND CLARIFICATION

The purpose of this Technical Guidance Document (TGD) is to outline a step by step procedure for complying with the minimum requirements necessary to perform an exposure assessment. An Exposure Assessment Report shall be submitted after all contaminant plumes have been defined to the applicable cleanup levels as required by Rule 1200-1-15-.06(6) and an Environmental Assessment Report (EAR) has been prepared and submitted in accordance with instructions supplied by the Division. The Exposure Assessment is being required by the Division of Underground Storage Tanks in accordance with rule 1200-1-15-.06(7)(a), which authorizes the Division to require owners and/or operators to submit additional information. The Exposure Assessment should be performed in accordance with this guidance document. Development of the Exposure Assessment Report shall be based on a current comprehensive monitoring event that includes all chemicals of concern (COCs) identified as applicable.

This guidance document shall be used to determine site-specific cleanup levels for the COCs that will provide adequate protection of human health and/or the environment. As a result of this determination, corrective action activities may be necessary to reduce the presence of certain COCs to achieve the site-specific cleanup levels¹. The determination for Total Petroleum Hydrocarbon (TPH) will be based on the presence of naphthalene and the Division's other PAH listed chemicals. Determination of the site-specific cleanup levels of naphthalene and other PAH chemical concentrations will determine the corresponding site conditions to be achieved to render a no further action status for TPH.

¹ The site-specific cleanup levels are aqueous phase levels that will provide adequate protection of human health and/or the environment. The relationship between aqueous phase contamination and non-aqueous phase contamination shall be evaluated to design an appropriate corrective action solution for the site. In accordance with Rule 1200-1-15-.06(4), non-aqueous phase contamination shall be removed to the maximum extent practicable as determined by the Division.

*This document includes the replacement pages issued by the division in September of 2002.

The Exposure Assessment Report shall be prepared and submitted in report format in accordance with this guidance document. Each section of the report shall contain the required elements of that section and provide reference to any associated tables and maps. Any information that is not specifically requested but is relevant to the evaluation shall also be included². The preparer shall assemble the required information in the order presented within this document so as to provide a comprehensive report. Each section and item heading shall be clearly identified in the report. A table of contents shall be provided listing the location of all sections, maps, tables, and appendices. All calculations must be shown.

Through evaluation in accordance with this guidance document, owners and/or operators that determine no further corrective action activities are necessary may request site-specific cleanup levels indicative of current site conditions by submitting a site-specific standard request (SSR) according to the instructions and format in Attachment 6. Site-specific standard requests for concentrations significantly higher than current site conditions will not be granted, since increases to those levels may denote a change in site conditions. A site-specific standard may be requested for levels to account for seasonal ground water fluctuations. If a higher standard is requested, the risk evaluation must be performed using the requested levels.

Owners and/or operators may also submit a SSR according to the instructions and format in Attachment 6 to petition for the site-specific cleanup levels that this guidance indicates will provide adequate protection of human health and/or the environment. The site-specific cleanup levels will then be used to design a Corrective Action Plan (CAP) to meet these corrective action level goals.

Submittal does not assure approval of a SSR by the Commissioner. The owner and/or operator may petition the Commissioner of the Department of Environment and Conservation to grant a site-specific standard if:

1. “The owner and/or operator has treated petroleum contamination at a site for an extended period of time and the treatment system for soil and/or ground water has reached asymptotic levels for contaminant removal” as stated in Rule 1200-1-15-.06(7)(e)3.
2. “The owner and/or operator believes that a particular site should not be subject to the cleanup requirements in Appendices 4 and 5” as stated in Rule 1200-1-15-.06(7)(e)4. This includes submittal of a SSR to establish site-specific standards for use in designing a CAP to remediate a site. If the SSR is approved, the site shall be remediated to the newly established site-specific standards rather than to the generic cleanup levels listed in Appendices 4 and 5 following Rule 1200-1-15-.07.

If a site-specific standard is granted, it may be revoked in accordance with Rule 1200-1-15-.06(7)(e)5 if it is later determined that the information supplied in the request was not accurate or

² It should be noted that costs associated with the collection and reporting of non-required information may not be reimbursable by the Tennessee Petroleum Underground Storage Tank Fund. Pre-approval of such work by the Division case manager is recommended to assure the tank owner and/or operator will know in advance if the cost must be born solely by the owner/operator.

there has been a change in the information supplied or in actual site conditions. Should the Commissioner deny the properly completed SSR or revoke the site-specific standard, the owner and/or operator may petition the Petroleum Underground Storage Tank Board for the site-specific standard.

DEFINITIONS

Asymptotic – “Asymptotic” means a graphical representation of the level of contaminant remaining in soil and/or ground water, where the y-axis of the graph indicates contaminant levels and the x-axis represents length of treatment. Samples of the soil and/or ground water shall be taken quarterly. After the slope of the graph approximates the slope of the x-axis, using the data from four consecutive quarters, an asymptotic level of treatment would have been reached; provided that the contaminant treatment system has been properly designed and operated.

Chemicals of Concern (COCs) – “Chemicals of concern” means those chemicals that have been designated as such by the Division in a chemicals of concern table (the most recent is attached as Reference 1). The COCs shall be chemicals that are constituents of or result from the degradation of petroleum product(s) and/or additives released from regulated petroleum underground storage tanks.

PAH – “PAH” means the polycyclic aromatic hydrocarbons listed by the Division in Reference 2 of this document.

Petroleum Site – “Petroleum Site” means any site or area where a petroleum underground storage tank is located.

Source Area – “Source area” means either the location of free product or the location of highest soil and/or ground water concentrations of the chemical(s) of concern.

REQUIRED INFORMATION AND REPORT FORMAT

I. Executive Summary

Provide an Executive Summary describing case development to date. Include conclusions and interpretation of data derived from implementing all environmental assessment and corrective action activities. The summary shall include the applicable cleanup levels as established in the Initial Site Characterization Report (ISCR) and/or the Environmental Assessment Report (EAR) and the site-specific cleanup levels for the COC.

II. Physical and Chemical Characteristics of the Contaminant Plume(s)

Provide the information listed in this section.

A. Physical

1. Scaled plan view maps showing the extent of contamination in accordance with Sections C.4.a. and D.6.a. of the Environmental Assessment Report Guidelines. The maps shall be constructed from the most recent comprehensive monitoring data. Maps shall be constructed for free product, if applicable, and any COC present above detection limits in more than 1 monitoring well.
2. The known source(s) of petroleum contamination, type of petroleum product released, and estimated amount released.
3. The interpreted source area(s) from historical contaminant plume maps constructed as described in Item A.1 of this section if release points are unknown. Areas where soil contamination continues to act as a secondary source for groundwater contamination must be a part of this data interpretation even if the soil contaminant levels are below the levels in Appendix 5 following Rule 1200-1-15-07.
4. The background level of each constituent in both the soil and ground water of the area if **naturally-occurring** petroleum is suspected to exist upgradient of the contaminant plume(s).
5. The media (i.e., soil, ground water, etc.) through which the release is spreading or is likely to spread, the direction, and the rate (note: permeability is not acceptable for use as hydraulic conductivity in calculation of ground water flow velocity).

B. Chemical

List the COCs for soil and ground water that are applicable, as determined from the most recent comprehensive monitoring event. Properties of the COCs are listed in Reference 3. Toxicity parameters for the COCs are listed in Reference 4.

III. Hydrogeologic Characteristics of the Petroleum Site and the Surrounding Land

Provide the information listed in this section.

- A. The soil permeability as reported in the ISCR and/or EAR
- B. Ground water recharge area, including map

- C. A summary of the hydrology (ground water flow gradient, direction, hydrologic boundaries and the occurrence of main aquifers or water bearing zones) as presented in the ISCR and/or EAR

IV. Proximity, Quality, and Current and Future Uses of Ground Water

Provide the information listed in this section.

- A. The ground water classification of the aquifer or water source (i.e., drinking water supply or non-drinking water supply) as reported in the ISCR and/or EAR
- B. The results from performing a current water use survey, including any current and/or reasonably expected future uses of the ground water within a one half (0.5) mile radius of the petroleum site (Provide a color topographic map showing the location of all wells and springs as required in Section D.6.a. of the ISCR Guidelines)
- C. The depth to each aquifer or water bearing zone encountered during the investigation

V. Proximity, Quality, and Current and Future Uses of Surface Waters

Provide the information listed in this section.

- A. Any surface waters within a one half (0.5) mile radius and the petroleum site location indicated on a color topographic map (This map shall be on 8.5 x 11 or 11 x 17 inch paper.)
- B. Any current and/or reasonably expected future uses of surface waters within a one half (0.5) mile radius (i.e., drinking water source, recreation, etc.)

VI. Risk Evaluation

Perform the risk evaluation by providing the information listed in this section. Completed Attachments 1 and 2 shall be included in the report. **Please pay careful attention when using the Risk-Based Screening Level (RBSL) tables in this section due to the use of scientific notation. Incorrect decimal placement may significantly alter the outcome of this evaluation.** Default parameters used in the RBSL calculations are included in Reference 5 and Reference 6.

A. Determine Pathways

Using Attachment 1, determine if the potential transport mechanisms and exposure routes exist for the petroleum contamination. Once a decision has been made concerning the applicability of a pathway, indicated by a “Yes” or a “No” in the third column of the table entitled “Exposure Assessment; Potential Human

Exposure Pathways”, the rationale for the decision must be included in Column 4 of the table.

The potential for degradation of water supply lines, the movement of vapors into storm and sanitary sewers, and damages to underground gas, phone, and electrical utilities must be evaluated as part of this subsection. An evaluation must be made which (1) delineates the presence and location, including depth, of various utilities on and adjacent to the petroleum release site, (2) determines the vulnerability of these utilities based on the construction materials used, and (3) reports any potential incompatibility of those materials with petroleum products present in the environment.

B. Determine On-site and Off-site Receptors

Using Attachment 2, determine the current and reasonably expected future receptors (on and off-site). The reason for selection or exclusion of each receptor must be included. Receptors shall be included where any of the following conditions exist or have previously existed:

- A drinking water supply has been impacted
- Presence of petroleum vapors in an enclosed space
- Any surface water on or near the petroleum site has been visibly, or otherwise confirmed, to have been impacted by petroleum

C. Compare Receptors to On-site Risk-Based Screening Levels

Evaluate all on-site receptors that have complete pathways for exposure. Compare the actual on-site concentrations and requested site-specific standards (if applicable) of the COCs, excluding TPH, to the applicable RBSL table values³ in Tables 1 through 4 (derived from the default parameters in References 3 and 4) and the applicable Surface Water Criteria in Table 5.

Provide a table for each applicable receptor formatted as shown in Attachment 3. Enter “NA” for source medium/transport mechanisms and exposure routes that are not applicable as indicated in Attachment 1. All RBSLs and Surface Water Criteria that are exceeded shall be highlighted in the table.

D. Evaluate Off-site Receptors Using Fate/Transport Models

Evaluate all off-site receptors that have complete pathways for exposure by using the Fate and Transport Models and the Cross-Media Transfer Definitions and Fate

³ RBSL values for inhalation are based on shallow source depths (i.e., worst case scenario). Concentrations that exceed the RBSL values for inhalation should be further evaluated using equations, such as those provided in ASTM Standard E 1739-95, applicable to evaluation of the chemical of concern according to the exposure pathway, route, and receptor, using the source depth applicable to the site. Only variables for which site-specific data are available may be changed (i.e., variables that are measures of distance and/or specific hydrogeologic properties). Variables that are chemical specific and risk constants may not be changed. All variables and calculations shall be shown.

and Transport Parameters in Attachment 4. If site-specific data are unobtainable, the default values provided in Attachment 4 shall be used. This evaluation must include a comparison of the predicted fate and transport of the COCs to the actual contaminant plume. This comparison must indicate that the predicted fate and transport is equivalent to or more conservative than contaminant plume conditions based on (1) known properties of the aquifer as discovered in the investigation, (2) historical contaminant concentrations, and (3) behavior of the plume. If fate and transport is higher than the model predicts, discuss the reasons for higher transport. There must be at least one compliance monitoring point between the source area monitoring point and the receptor to perform this comparison. If a monitoring well does not exist between the source area and a receptor, the Division case manager shall be notified.

1. The maximum soil concentrations of the COCs, excluding TPH, from the most recent sampling event shall be evaluated using the Soil to Ground Water Leaching Equation.
2. The actual on-site concentrations and requested site-specific standards (if applicable) for the COCs, excluding TPH, shall be evaluated using the Domenico Ground Water Solute Transport Model.
3. The groundwater concentration at the receptor point shall be compared to the applicable RBSLs and Surface Water Criteria in Tables 1 through 5.
4. Provide a table for each applicable receptor that reports LF_{sw} , $C_{max\ soil}$, $C_{leaching}$, $C_{max\ gw}$, $C_{source\ gw}$ and compares the $C(x)$ to the applicable RBSLs and Surface Water Criteria for all COCs. The table shall be formatted as shown in Attachment 5. Enter “NA” for source medium/transport mechanisms and exposure routes that are not applicable. All RBSLs and Surface Water Criteria that are exceeded shall be highlighted in the table.
5. If any RBSLs or Surface Water Criteria are exceeded in item 4, re-evaluate them using this section to determine the C_{source} value that will not result in a value greater than the applicable RBSLs and Surface Water Criteria. All calculations shall be shown.

VII. Summary

- A. The summary shall list the most restrictive soil and ground water cleanup level for each COC that was determined through the exposure assessment. The most restrictive cleanup levels for soil will be the lowest soil RBSLs highlighted in the table generated in Section VI.C. The most restrictive cleanup levels for ground water will be the lower of (1) the lowest ground water RBSLs and Surface Water Criteria highlighted in the table generated in Section VI.C or (2) the $C_{source\ gw}$ level which will not result in a value greater than the applicable RBSLs and Surface Water Criteria in the off-site exposure assessment.

- B. The summary shall state whether a potential for degradation of water supply lines, movement of vapors into storm and sanitary sewers, or damages to underground gas, phone, and electrical utilities exists or is likely to exist.
- C. The summary shall include a recommendation for corrective action activities, monitoring, and/or a site-specific standard request based on conclusions supported by the exposure assessment. (Note: Site-specific standard requests for concentrations higher than the most restrictive cleanup level for each COC will not be granted unless site-specific data is used to demonstrate that a higher concentration of the chemical of concern will provide adequate protection of human health and/or the environment. The Division does not currently provide software to complete the calculations necessary for this demonstration. This demonstration shall use equations, such as those provided in ASTM Standard E 1739-95, applicable to evaluation of the chemical of concern according to the exposure pathway, route, and receptor. Only variables for which site-specific data are available may be changed in this demonstration (i.e. variables that are measures of distance and/or specific hydrogeologic properties). Variables that are chemical specific and risk constants may not be changed.)

VIII. SIGNATURE PAGE

A signature page as shown below shall be attached to the Request. The page shall be signed by the owner/operator (or authorized representative within the organization), a registered professional geologist under the Tennessee Geologist Act (T.C.A. §62-36-101 et seq.), and a registered professional engineer under the Tennessee Architects, Engineers, Landscape Architects, and Interior Designers Law and Rules (T.C.A. §62-2-101 et seq.).

We, the undersigned, certify under penalty of law, including but not limited to penalties for perjury, that the information contained in this report form and on any attachments, is true, accurate and complete to the best of our knowledge, information, and belief. We are aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for intentional violations.

Owner/Operator (Print name)

Signature

Date

Title (Print)

P.G. (Print name)

Signature

Date

Tennessee Registration #

P.E. (Print name)

Signature

Date

Tennessee Registration #

Note: Each of the above signatures shall be notarized separately with the following statement.

STATE OF _____

COUNTY OF _____

Sworn to and subscribed before me by _____ on this date

_____. My commission expires _____.

Notary Public (Print name)

Signature

Date

ATTACHMENT 1**Potential Human Exposure Pathways**

Source Medium	Transport Mechanism and Exposure Route	Pathway Applicable?	Reason For Selection or Exclusion
Surficial Soil (0-1ft.)	Direct Contact - Inhalation, Dermal Contact, Ingestion, & Particulate Inhalation	Yes/No	
	Wind Erosion/Dispersion - Inhalation, Dermal Contact, Ingestion, & Particulate Inhalation	Yes/No	
	Volatilization and Migration - Inhalation (ambient vapors)	Yes/No	
	Volatilization and Migration - Inhalation (enclosed space vapors)	Yes/No	
Subsurface Soil (>1ft.)	Leaching to Dissolved Phase	Yes/No	
	Direct Contact - Inhalation, Dermal Contact, Ingestion, & Particulate Inhalation	Yes/No	
	Volatilization and Migration - Inhalation (ambient vapors)	Yes/No	
	Volatilization and Migration - Inhalation (enclosed space vapors)	Yes/No	
Dissolved Phase (Aqueous Phase Contamination)	Leaching to Dissolved Phase	Yes/No	
	Direct Contact and/or Volatilization - Utility Water	Yes/No	
	Ground Water Transport - Ingestion of Potable Water	Yes/No	
	Direct Contact - Inhalation, Dermal Contact, & Ingestion of Non-Potable Water	Yes/No	
Volatilization and Migration - Inhalation (ambient vapors)	Volatilization and Migration - Inhalation (enclosed space vapors)	Yes/No	
	Direct Contact and/or Volatilization - Utility	Yes/No	

ATTACHMENT 2**Potential Receptors**

Location	Potential Receptor	Selected?	Reason for Selection or Exclusion
CURRENT			
On-Site	Resident (Adult or Child)	Yes/No	
	Commercial Worker	Yes/No	
	Construction Worker	Yes/No	
	Surface Water (use does not include Domestic Water Supply)	Yes/No	
Off-Site	Surface Water(use includes Domestic Water Supply)	Yes/No	
	Resident (Adult or Child)	Yes/No	
	Commercial Worker	Yes/No	
	Construction Worker	Yes/No	
	Surface Water (use does not include Domestic Water Supply)	Yes/No	
	Surface Water(use includes Domestic Water Supply)	Yes/No	
	Surface Water(use does not include Domestic Water Supply)	Yes/No	
	Surface Water(use includes Domestic Water Supply)	Yes/No	
FUTURE			
On-Site	Resident (Adult or Child)	Yes/No	
	Commercial Worker	Yes/No	
	Construction Worker	Yes/No	
	Surface Water (use does not include Domestic Water Supply)	Yes/No	
Off-Site	Surface Water(use includes Domestic Water Supply)	Yes/No	
	Resident (Adult or Child)	Yes/No	
	Commercial Worker	Yes/No	
	Construction Worker	Yes/No	
	Surface Water (use does not include Domestic Water Supply)	Yes/No	
	Surface Water(use includes Domestic Water Supply)	Yes/No	
	Surface Water(use does not include Domestic Water Supply)	Yes/No	
	Surface Water(use includes Domestic Water Supply)	Yes/No	

List all receptors identified by answering yes. Give names, addresses, phone number, creek location, etc. and specify distance and direction from the source area for each.

ATTACHMENT 3

(Applicable Receptor))

ATTACHMENT 4

Fate and Transport Models

Soil to Ground Water Leaching Equation

$$LF_{sw} = K_{sw} / \alpha$$

Soil to Leachate Partition:

$$K_{sw} = \frac{\rho_s}{\theta_{ws} + k_s \rho_s + H \theta_{as}}$$

where $k_s = k_{oc} x f_{oc}$

Leachate to Ground Water Dilution Factor:

$$\alpha = 1 + \frac{U_{gw} \delta_{gw}}{I \times S_W}$$

$$C_{Leaching} = C_{max\ soil} (LF_{sw})$$

Cross-Media Transfer Definitions and Fate and Transport Parameters:

(If site-specific data are unobtainable, the default values shall be used.)

LF _{sw}	Leaching Factor: Soil to ground water (ppm/ppm)
C _{Leaching}	Concentration in ground water contributed by leaching (ppm)
K _{sw}	Soil to Leachate Partition (ppm-H ₂ O/ppm-soil)
α	Leachate to ground water dilution factor (unitless)
ρ _s	Soil bulk density (g-soil/cm ³ -soil); default value = 1.8
θ _{ws}	Volumetric water content in vadose zone soils (cm ³ -H ₂ O/cm ³ -soil); default value = 0.1
k _s	Soil-water sorption coefficient (g-H ₂ O/g-soil)
H	Henry's law constant(unitless)
θ _{as}	Volumetric air content in vadose zone soils (cm ³ -air/cm ³ -soil); default value = 0.2
k _{oc}	Carbon-water sorption coefficient(cm ² -H ₂ O/g-carbon)
f _{oc}	Fractional organic carbon; default value = 0.01
U _{gw}	Ground water Darcy velocity (cm/yr)
δ _{gw}	Ground water mixing zone thickness (cm); default value = 200
I	Infiltration rate of water through soil (cm/yr); default value = 15.2
S _W	Width of source area parallel to wind, or ground water flow direction (cm)
C _{max soil}	Maximum soil concentration on-site (ppm)

ATTACHMENT 4 (continued)

Fate and Transport Models

Domenico Ground Water Solute Transport Model

$$\frac{C(x)}{C_{source\ gw}} = \exp\left(\frac{x}{2\alpha_x}\left[1 - \sqrt{1 + \frac{4\lambda\alpha_x}{u}}\right]\right) \times \operatorname{erf}\left(\frac{S_w}{4\sqrt{\alpha_y x}}\right) \times \operatorname{erf}\left(\frac{S_d}{4\sqrt{\alpha_z x}}\right)$$

where,

$$C_{source\ gw} = C_{Leaching} + C_{max\ gw} \text{ and } u = \frac{ki}{\theta}$$

For this evaluation the Division requires $\lambda=0$. Therefore, the equation for the Domenico Model to be used in this evaluation is:

$$\frac{C(x)}{C_{source\ gw}} = \operatorname{erf}\left(\frac{S_w}{4\sqrt{\alpha_y x}}\right) \times \operatorname{erf}\left(\frac{S_d}{4\sqrt{\alpha_z x}}\right)$$

S_w (cm) = Source width parallel to the flow in the horizontal plane = site specific

S_d (cm) = Source depth = 200

x (cm) = Distance to nearest receptor = site specific

α_x (cm) = $0.10x$ = Longitudinal Dispersivity

α_y (cm) = $\frac{\alpha_x}{3}$ = Transverse Dispersivity

α_z (cm) = $\frac{\alpha_x}{20}$ = Vertical Dispersivity

Cross-Media Transfer Definitions

LF_{sw}	Leaching Factor: Soil to ground water (ppm/ppm)
$C_{Leaching}$	Concentration in ground water contributed by leaching (ppm)

Fate and Transport Parameters

K_{sw}	Soil to Leachate Partition (ppm-H ₂ O/ppm-soil)
α	Leachate to ground water dilution factor (unitless)
ρ_s	Soil bulk density (g-soil/cm ³ -soil); default value = 1.8
θ_{ws}	Volumetric water content in vadose zone soils (cm ³ -H ₂ O/cm ³ -soil); default value = 0.1
k_s	Soil-water sorption coefficient (g-H ₂ O/g-soil)
k_{oc}	Carbon-water sorption coefficient(cm ² -H ₂ O/g-carbon)
f_{oc}	Fractional organic carbon
H	Henry's law constant(unitless)
θ_{as}	Volumetric air content in vadose zone soils (cm ³ -air/cm ³ -soil); default value = 0.2

ATTACHMENT 4 (continued)

Fate and Transport Models

Fate and Transport Parameters (continued)

U_{gw}	Ground water Darcy velocity (cm/yr)
δ_{gw}	Ground water mixing zone thickness (cm)
I	Infiltration rate of water through soil (cm/yr); default value = 15.2
W	Width of source area parallel to wind, or ground water flow direction (cm)
$C_{max\ soil}$	Maximum soil concentration on-site (ppm)
$C_{max\ gw}$	Maximum ground water concentration on-site (ppm)
$C_{source\ gw}$	Ground water concentration in Source Zone (ppm)
$C(x)$	Concentration at the receptor point (ppm)
x	Distance to receptor (cm)
α_x	Longitudinal Dispersivity (cm)
α_y	Transverse Dispersivity (cm)
α_z	Vertical Dispersivity (cm)
λ	First-Order Degradation Rate (day ⁻¹)
u	Specific Discharge (cm/day)
S_w	Source Width (cm)
S_d	Source Depth (cm)
C_{gw}	Maximum concentration of contaminant on-site (ppm)
k	Hydraulic Conductivity (cm/day)
i	Hydraulic Gradient (cm/cm)
θ	Porosity

Reference: ASTM Standard: E 1739-95 Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites

ATTACHMENT 5

(Applicable Receptor)

ATTACHMENT 6

Procedure for Submitting a Site-specific Standard Request

The owner and/or operator may petition the Commissioner for a site-specific standard in accordance with Rule 1200-1-15-.06(7)(e). The site-specific standard request (SSR) shall be submitted to the Division of Underground Storage Tanks (DUST) as Attachment 6 to the Exposure Assessment Report. The SSR shall be in the format of a letter addressed to the DUST director. The letter shall contain paragraphs with the following information:

- **Justification of Proposed Standard** - A summary including statement of the proposed site-specific cleanup levels and a justification of the proposed levels based on all available information. The justification shall include a discussion of all risk(s) to human health and/or environment as determined in the exposure assessment.
- **Recommendation for Closure** – A statement recommending a schedule for performing at least four quarters of closure monitoring and reporting in accordance with Technical Guidance Document – 007 after the site-specific cleanup levels are met. This paragraph shall also include a recommendation for obtaining a “no further action” letter after the approved closure monitoring indicates contamination levels remain below the site-specific cleanup levels.

TABLE 1

CHEMICALS OF CONCERN	SURFICIAL SOIL	SUB-SURFACE SOIL		GROUND WATER		
	Surficial Soil: Ingestion, Inhalation (Vapor Emissions and Particulates), and Dermal Contact (ppm)	Indoor Inhalation of Vapor Emissions (ppm)	Outdoor Inhalation of Vapor Emissions (ppm)	Indoor Inhalation of Vapor Emissions (ppm)	Outdoor Inhalation of Vapor Emissions (ppm)	Ingestion of Water (ppm)
ORGANICS						
Benzene	6.83E+01	9.69E-02	2.07E+00	1.83E-01	8.43E+01	5.00E-03
Toluene	7.67E+02 ¹	9.15E+00	1.95E+02	1.11E+01	5.35E+02 ²	1.00E+00
Ethylbenzene	1.82E+03	1.99E+02	1.97E+03 ¹	2.69E+01	1.52E+02 ²	7.00E-01
Xylenes (Total)	4.93E+02 ¹	1.31E+01	2.80E+02	9.23E+00	1.98E+02 ²	1.00E+01
MTBE	9.47E+01	4.68E+01	1.00E+03	3.85E+02	4.80E+04 ²	2.00E-02
Acenaphthene	3.57E+00	2.07E+02 ¹	2.07E+02 ¹	4.24E+00 ²	4.24E+00 ²	4.70E-01
Acenaphthylene	NA	NA	NA	NA	NA	NA
Anthracene	1.02E+01 ¹	1.02E+01 ¹	1.02E+01 ¹	4.34E-02 ²	4.34E-02 ²	4.34E-02 ²
Benz(a)anthracene	9.51E+00	3.37E+01 ¹	3.37E+01 ¹	9.40E-03 ²	9.40E-03 ²	1.17E-03
Benz(b)fluoranthene	9.50E+00	1.85E+01 ¹	1.85E+01 ¹	1.50E-03 ²	1.50E-03 ²	1.17E-03
Benz(k)fluoranthene	9.52E+00	9.84E+00 ¹	9.84E+00 ¹	8.00E-04 ²	8.00E-04 ²	8.00E-04 ²
Benz(a)pyrene	9.52E-01	4.67E+00 ¹	4.67E+00 ¹	1.20E-03 ²	1.20E-03 ²	2.00E-04
Benz(g,h,i) perylene	1.11E+01 ¹	1.11E+01 ¹	1.11E+01 ¹	7.00E-04 ²	7.00E-04 ²	7.00E-04 ²
Chrysene	6.37E+00 ¹	6.37E+00 ¹	6.37E+00 ¹	1.60E-03 ²	1.60E-03 ²	1.60E-03 ²
Dibenz(a,h)anthracene	6.23E-01	4.45E+01 ¹	4.45E+01 ¹	2.49E-03 ²	2.49E-03 ²	5.00E-05
EDB	9.80E-02	1.90E+01	1.62E+02	4.18E+03 ²	4.18E+03 ²	5.00E-05
EDC	1.53E+01	2.40E-01	2.14E+00	8.00E+01	2.25E+02	4.01E-03
Fluorene	1.53E+02 ¹	1.53E+02 ¹	1.53E+02 ¹	1.98E+00 ²	1.98E+00 ²	1.46E+00
Fluoranthene	1.01E+02 ¹	1.01E+02 ¹	1.01E+02 ¹	2.06E-01 ²	2.06E-01 ²	2.06E-01 ²
Indeno(1,2,3-c,d)pyrene	7.63E-01 ¹	7.63E-01 ¹	7.63E-01 ¹	2.20E-05 ²	2.20E-05 ²	5.00E-04
Naphthalene	4.02E+02 ¹	1.88E+02	4.02E+02 ¹	2.13E+01	3.10E+01 ²	2.00E-02
Phenanthrene	1.41E+02 ¹	1.41E+02 ¹	1.41E+02 ¹	1.00E+00 ²	1.00E+00 ²	1.00E+00 ²
Pyrene	9.18E+01 ¹	9.18E+01 ¹	9.18E+01 ¹	1.35E-01 ²	1.35E-01 ²	1.35E-01 ²
METALS						
Cadmium	3.89E+01	NA	NA	NA	NA	5.00E-03
Chromium	3.88E+02	NA	NA	NA	NA	1.00E-01
Lead	4.00E+02	NA	NA	NA	NA	1.50E-02
Silver	3.91E+02	NA	NA	NA	NA	1.00E-01
Zinc	2.33E+04	NA	NA	NA	NA	5.00E+00

NOTES:

NA - Not Applicable

¹ Calculated RB_{SL} exceeded saturated soil concentration, therefore, saturated soil concentration is listed RB_{SL}² Calculated RB_{SL} exceeded pure component water solubility, therefore, water solubility is listed RB_{SL}

TABLE 2

CHEMICALS OF CONCERN	SURFICIAL SOIL		SUB-SURFACE SOIL		GROUND WATER	
	Surficial Soil: Ingestion, Inhalation (Vapor Emissions and Particulates), and Dermal Contact (ppm)	(ppm)	Indoor Inhalation of Vapor Emissions	Outdoor Inhalation of Vapor Emissions	Indoor Inhalation of Vapor Emissions	Outdoor Inhalation of Vapor Emissions
ORGANICS						
Benzene	4.26E+01	1.41E-01	3.05E+00	2.66E-01	1.24E+02	5.00E-03
Toluene	7.67E+02 ¹	2.81E+01	6.08E+02	3.42E+01	5.35E+02 ²	1.00E+00
Ethylbenzene	1.97E+03 ¹	6.10E+02	1.97E+03 ¹	8.28E+01	1.52E+02 ²	7.00E-01
Xylenes (Total)	4.93E+02 ¹	4.04E+01	4.93E+02 ¹	2.84E+01	1.98E+02 ²	1.00E+01
MTBE	2.70E+02	1.44E+02	3.11E+03	1.18E+03	4.80E+04 ²	2.00E-02
Acenaphthene	1.95E+01	2.07E+02 ¹	2.07E+02 ¹	4.24E+00 ²	4.24E+00 ²	4.70E-01
Acenaphthylene	NA	NA	NA	NA	NA	NA
Anthracene	1.02E+01 ¹	1.02E+01 ¹	1.02E+01 ¹	4.34E+02 ²	4.34E+02 ²	4.34E-02 ²
Benz(a)anthracene	1.04E+01	3.37E+01 ¹	3.37E+01 ¹	9.40E+03 ²	9.40E+03 ²	1.17E-03
Benz(b)fluoranthene	1.04E+01	1.85E+01 ¹	1.85E+01 ¹	1.50E+03 ²	1.50E+03 ²	1.17E-03
Benz(k)fluoranthene	9.84E+00 ¹	9.84E+00 ¹	9.84E+00 ¹	8.00E+04 ²	8.00E+04 ²	8.00E-04 ²
Benz(a)pyrene	1.04E+00	4.67E+00 ¹	4.67E+00 ¹	1.20E+03 ²	1.20E+03 ²	2.00E-04 ²
Benz(g,h,i)perylene	1.11E+01 ¹	1.11E+01 ¹	1.11E+01 ¹	7.00E+04 ²	7.00E+04 ²	7.00E-04 ²
Chrysene	6.37E+00 ¹	6.37E+00 ¹	6.37E+00 ¹	1.60E+03 ²	1.60E+03 ²	1.60E-03 ²
Dibenz(a,h)anthracene	4.69E-01	4.45E+01 ¹	4.45E+01 ¹	2.49E+03 ²	2.49E+03 ²	5.00E-05
EDB	1.34E-01	1.17E+01	9.96E+01	4.18E+03 ²	4.18E+03 ²	5.00E-05
EDC	3.55E+00	1.50E+01	1.33E+00	5.00E+01	1.12E+02	4.01E-03
Fluorene	1.53E+02 ¹	1.53E+02 ¹	1.53E+02 ¹	1.98E+00 ²	1.98E+00 ²	1.46E+00
Fluoranthene	1.01E+02 ¹	1.01E+02 ¹	1.01E+02 ¹	2.06E+01 ²	2.06E+01 ²	2.06E-01 ²
Indeno(1,2,3-c,d)pyrene	7.63E-01 ¹	7.63E-01 ¹	7.63E-01 ¹	2.20E+05 ²	2.20E+05 ²	5.00E-04 ²
Naphthalene	4.02E+02 ¹	4.02E+02 ¹	4.02E+02 ¹	3.10E+01 ²	3.10E+01 ²	2.00E-02
Phenanthrene	1.41E+02 ¹	1.41E+02 ¹	1.41E+02 ¹	1.00E+00 ²	1.00E+00 ²	1.00E+00 ²
Pyrene	9.18E+01 ¹	9.18E+01 ¹	9.18E+01 ¹	1.35E+01 ²	1.35E+01 ²	1.35E-01 ²
METALS						
Cadmium	3.56E+02	NA	NA	NA	NA	5.00E-03
Chromium	3.55E+03	NA	NA	NA	NA	1.00E-01
Lead	4.00E+02	NA	NA	NA	NA	1.50E-02
Silver	3.65E+03	NA	NA	NA	NA	1.00E-01
Zinc	2.14E+05	NA	NA	NA	NA	5.00E+00

NOTES:

NA - Not Applicable

¹ Calculated RBSL exceeded saturated soil concentration, therefore, saturated soil concentration is listed RBSL² Calculated RBSL exceeded pure component water solubility, therefore, water solubility is listed RBSL

TABLE 3

CHEMICALS OF CONCERN	RISK-BASED SCREENING LEVELS FOR A COMMERCIAL WORKER		GROUND WATER	
	SURFICIAL SOIL	SUB-SURFACE SOIL	Indoor Inhalation of Vapor Emissions	Outdoor Inhalation of Vapor Emissions
ORGANICS			(ppm)	(ppm)
Benzene	7.39E+01	5.91E-01	5.12E+00	1.12E+00
Toluene	7.67E+02 ¹	9.83E+01	7.67E+02 ¹	1.19E+02
Ethylbenzene	1.97E+03 ¹	1.97E+03 ¹	1.97E+03 ¹	1.52E+02 ²
Xylenes (Total)	4.93E+02 ¹	1.41 E+02	4.93E+02 ¹	9.91 E+01
MTBE	3.93E+02	5.03E+02	4.36E+03	4.13E+03
Acenaphthene	3.50E+01	2.07E+02 ¹	2.07E+02 ¹	4.24E+00 ²
Acenaphthylene	NA	NA	NA	NA
Anthracene	1.02E+01 ¹	1.02E+01 ¹	1.02E+01 ¹	4.34E+02 ²
Benz(a)anthracene	2.24E+01	3.37E+01 ¹	3.37E+01 ¹	9.40E+03 ²
Benz(b)fluoranthene	1.85E+01 ¹	1.85E+01 ¹	1.85E+01 ¹	1.50E+03 ²
Benz(k)fluoranthene	9.84E+00 ¹	9.84E+00 ¹	9.84E+00 ¹	8.00E-04 ²
Benz(a)pyrene	2.24E+00	4.67E+00 ¹	4.67E+00 ¹	1.20E+03 ²
Benz(g,h,i)perylene	1.11E+01 ¹	1.11E+01 ¹	1.11E+01 ¹	7.00E-04 ²
Chrysene	6.37E+00 ¹	6.37E+00 ¹	6.37E+00 ¹	1.60E-03 ²
Dibenz(a,h)anthracene	8.66E-01	4.45E+01 ¹	4.45E+01 ¹	2.49E+03 ²
EDB	3.39E-01	1.92E+01	1.67E+02	4.18E+03 ²
EDC	6.04E+00	2.62E+01	2.24E+00	2.62E+02
Fluorene	1.53E+02 ¹	1.53E+02 ¹	1.53E+02 ¹	1.98E+00 ²
Fluoranthene	1.01E+02 ¹	1.01E+02 ¹	1.01E+02 ¹	2.06E+01 ²
Indeno(1,2,3-c,d)pyrene	7.63E-01 ¹	7.63E-01 ¹	7.63E-01 ¹	2.20E+05 ²
Naphthalene	4.02E+02 ¹	4.02E+02 ¹	4.02E+02 ¹	3.10E+01 ²
Phenanthrene	1.41 E+02 ¹	1.41 E+02 ¹	1.41 E+02 ¹	1.00E+00 ²
Pyrene	9.18E+01 ¹	9.18E+01 ¹	9.18E+01 ¹	1.35E+01 ²
METALS				
Cadmium	9.73E+02	NA	NA	NA
Chromium	9.68E+03	NA	NA	NA
Lead	4.00E+02	NA	NA	NA
Silver	1.02E+04	NA	NA	NA
Zinc	5.84E+05	NA	NA	NA

NOTES:

NA - Not Applicable

¹ Calculated RBSL exceeded saturated soil concentration, therefore, saturated soil concentration is listed RBSL² Calculated RBSL exceeded pure component water solubility, therefore, water solubility is listed RBSL

TABLE 4

CHEMICALS OF CONCERN	SURFICIAL SOIL	SUB-SURFACE SOIL		GROUND WATER		
	Surficial Soil: Ingestion, Inhalation (Vapor Emissions and Particulates), and Dermal Contact (ppm)	Indoor Inhalation of Vapor Emissions (ppm)	Outdoor Inhalation of Vapor Emissions (ppm)	Indoor Inhalation of Vapor Emissions (ppm)	Outdoor Inhalation of Vapor Emissions (ppm)	Ingestion of Water (ppm)
ORGANICS						
Benzene	1.99E+02	1.04E+00	9.01E+00	1.97E+00	3.67E+02	5.00E-03
Toluene	7.67E+02 ¹	9.83E+01	7.67E+02 ¹	1.19E+02	5.35E+02 ²	1.00E+00
Ethylbenzene	1.97E+03 ¹	1.97E+03 ¹	1.97E+03 ¹	1.52E+02 ²	1.52E+02 ²	7.00E-01
Xylenes (Total)	4.93E+02 ¹	1.41E+02	4.93E+02 ¹	9.91E+01	1.98E+02 ²	1.00E+01
MTBE	3.77E+02	5.03E+02	4.36E+03	4.13E+03	4.80E+04 ²	2.00E-02
Acenaphthene	2.73E+01	2.07E+02 ¹	2.07E+02 ¹	4.24E+00 ²	4.24E+00 ²	4.70E-01
Acenaphthylene	NA	NA	NA	NA	NA	NA
Anthracene	1.02E+01 ¹	1.02E+01 ¹	1.02E+01 ¹	4.34E-02 ²	4.34E-02 ²	4.34E-02 ²
Benzo(a)anthracene	3.37E+01 ¹	3.37E+01 ¹	3.37E+01 ¹	9.40E-03 ²	9.40E-03 ²	1.17E-03
Benzo(b)fluoranthene	1.85E+01 ¹	1.85E+01 ¹	1.85E+01 ¹	1.50E-03 ²	1.50E-03 ²	1.17E-03
Benzo(k)fluoranthene	9.84E+00 ¹	9.84E+00 ¹	9.84E+00 ¹	8.00E-04 ²	8.00E-04 ²	8.00E-04 ²
Benzo(a)pyrene	4.67E+00 ¹	4.67E+00 ¹	4.67E+00 ¹	1.20E-03 ²	1.20E-03 ²	2.00E-04
Benzo(g,h,i)perylene	1.11E+01 ¹	1.11E+01 ¹	1.11E+01 ¹	7.00E-04 ²	7.00E-04 ²	7.00E-04 ²
Chrysene	6.37E+00 ¹	6.37E+00 ¹	6.37E+00 ¹	1.60E-03 ²	1.60E-03 ²	1.60E-03 ²
Dibenz(a,h)anthracene	1.96E+01	4.45E+01 ¹	4.45E+01 ¹	2.49E-03 ²	2.49E-03 ²	5.00E-05
EDB	5.64E+00	4.76E+02	4.18E+03	4.18E+03 ²	4.18E+03 ²	5.00E-05
EDC	1.49E+02	6.55E+00	5.60E+01	6.55E+03	5.84E+03	4.01E-03
Fluorene	1.53E+02 ¹	1.53E+02 ¹	1.53E+02 ¹	1.98E+00 ²	1.98E+00 ²	1.46E+00
Fluoranthene	1.01E+02 ¹	1.01E+02 ¹	1.01E+02 ¹	2.06E-01 ²	2.06E-01 ²	2.06E-01 ²
Indeno(1,2,3-c,d)pyrene	7.63E-01 ¹	7.63E-01 ¹	7.63E-01 ¹	2.20E-05 ²	2.20E-05 ²	5.00E-04
Naphthalene	4.02E+02 ¹	4.02E+02 ¹	4.02E+02 ¹	3.10E+01 ²	3.10E+01 ²	2.00E-02
Phenanthrene	1.41E+02 ¹	1.41E+02 ¹	1.41E+02 ¹	1.00E+00 ²	1.00E+00 ²	1.00E+00 ²
Pyrene	9.18E+01 ¹	9.18E+01 ¹	9.18E+01 ¹	1.35E-01 ²	1.35E-01 ²	1.35E-01 ²
METALS						
Cadmium	4.99E+02	NA	NA	NA	NA	5.00E-03
Chromium	1.69E+01	NA	NA	NA	NA	1.00E-01
Lead	4.00E+02	NA	NA	NA	NA	1.50E-02
Silver	5.11E+03	NA	NA	NA	NA	1.00E-01
Zinc	1.49E+05	NA	NA	NA	NA	5.00E+00

NOTES:

NA - Not Applicable

¹ Calculated RBSL exceeded saturated soil concentration, therefore, saturated soil concentration is listed RBSL² Calculated RBSL exceeded pure component water solubility, therefore, water solubility is listed RBSL

TABLE 5

SURFACE WATER CRITERIA

CHEMICALS OF CONCERN	Use Includes Domestic Water Supply (ppm)	Use Does Not Include Domestic Water Supply (ppm)
Benzene	1.20E-02	7.10E-01
EDC	3.80E-03	9.90E-01
Ethylbenzene	3.10E+00	2.90E+01
Toluene	6.80E+00	2.00E+02
Acenaphthene	1.20E+00	2.70E+00
Anthracene	9.60E+00	1.10E+02
Benzo(a)anthracene	4.40E-05	4.90E-04
Benzo(a)pyrene	4.40E-05	4.90E-04
Benzo(b)fluoranthene	4.40E-05	4.90E-04
Benzo(k)fluoranthene	4.40E-05	4.90E-04
Chrysene	4.40E-05	4.90E-04
Dibenzo(a,h)anthracene	4.40E-05	4.90E-04
Fluorene	1.30E+00	1.40E+01
Fluoranthene	3.00E-01	3.70E-01
Indeno(1,2,3-c,d)pyrene	4.40E-05	4.90E-04
Pyrene	9.60E-01	1.10E+01

REFERENCE 1
Chemicals of Concern
Tennessee Division of Underground Storage Tanks
Effective November 1, 2001

Released Product	Chemicals To Sample
Gasoline	Benzene Ethylbenzene Toluene Total Xylenes MTBE Naphthalene GRO
Diesel Jet Fuel Kerosene	Benzene Ethylbenzene Toluene Total Xylenes MtBE PAHs EPH
Waste Oil Used Oil	EPH PAHs Cadmium Chromium Lead, Total Silver Zinc
Aviation Fuel	Benzene Ethylbenzene Toluene Total Xylenes MTBE EDC EDB GRO PAHs EPH Lead, Total

REFERENCE 2
TENNESSEE PAH LIST

Acenaphthene
Acenaphthylene
Anthracene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(b)fluoranthene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Chrysene
Dibenzo(a,h)anthracene
Fluoranthene
Fluorene
Indeno(1,2,3-c,d)pyrene
Naphthalene
Phenanthrene
Pyrene

REFERENCE 3

PHYSICAL AND CHEMICAL PROPERTIES

CHEMICAL	MOL. WT.	Koc	Ref	Henry's Constant	Ref	Diffusion Coefficient in Air	Ref	Diffusion Coefficient in Water	Ref	Pure Product Solubility	Ref
	[g/mole]	[ml water/g carbon]		[L water/L air]		[cm ² /s]		[cm ² /s]		[mg/l]	
ORGANICS											
Benzene	78	8.30E+01	1	2.20E-01	1	9.30E-02	1	1.10E-05	1	1.75E+03	1
Toluene	92	1.35E+02	1	2.60E-01	1	8.50E-02	1	9.40E-06	1	5.35E+02	1
Ethylbenzene	106	1.29E+03	1	3.20E-01	1	7.60E-02	1	8.50E-06	1	1.52E+02	1
Xylenes (Total)	106	2.40E+02	1	2.90E-01	1	7.20E-02	1	8.50E-06	1	1.98E+02	1
MTBE	88.15	1.20E+01	1	4.16E-02	1	1.02E-01	4	1.05E-05	4	4.80E+04	1
Acenaphthene	154.21	4.90E+03	2	6.36E-03	2	4.21E-02	2	7.69E-06	2	4.24E+00	2
Acenaphthylene	152.21	2.00E+03	5	4.67E-03	5	4.39E-02	5	7.53E-06	5	1.61E+01	5
Anthracene	178	2.35E+04	2	2.67E-03	2	3.24E-02	2	7.74E-06	2	4.34E-02	2
Benzo(a)anthracene	228	3.58E+05	2	1.37E-04	2	5.10E-02	2	9.00E-06	2	9.40E-03	2
Benzo(b)fluoranthene	252	1.23E+06	2	4.55E-03	2	2.26E-02	2	5.56E-06	2	1.50E-03	2
Benzo(k)fluoranthene	252	1.23E+06	2	3.40E-05	2	2.26E-02	2	5.56E-06	2	8.00E-04	2
Benzo(a)pyrene	252	3.89E+05	1	5.80E-08	1	5.00E-02	1	5.80E-06	1	1.20E-03	1
Benzo(g,h,i)perylene	276	1.58E+06	1	2.22E-06	6	2.16E-02	7	5.31E-06	7	7.00E-04	1
Chrysene	228	3.98E+05	2	3.88E-03	2	2.48E-02	2	6.21E-06	2	1.60E-03	2
Dibenzo(a,h)anthracene	278.35	1.79E+06	2	6.03E-07	2	2.02E-02	2	5.18E-06	2	2.49E-03	2
EDB	188	1.90E+02	5	2.66E-02	5	2.17E-02	5	1.19E-05	5	4.18E+03	5
EDC	99	1.74E+01	5	4.00E-02	5	1.04E-01	5	9.90E-06	5	8.52E+03	5
Fluorene	166	7.71E+03	2	2.61E-03	2	3.63E-02	2	7.88E-06	2	1.98E+00	2
Fluoranthene	202	4.91E+04	2	6.60E-04	2	3.02E-02	2	6.35E-06	2	2.06E-01	2
Indeno(1,2,3-c,d)pyrene	276.33	3.47E+06	2	6.56E-05	2	1.91E-02	2	5.66E-06	2	2.20E-05	2
Naphthalene	128	1.29E+03	1	4.90E-02	1	7.20E-02	1	9.40E-06	1	3.10E+01	1
Phenanthrene	178	1.41E+04	1	6.61E-03	6	3.24E-02	2	7.74E-06	2	1.00E+00	1
Pyrene	202	6.80E+04	2	4.51E-04	2	2.72E-02	2	7.24E-06	2	1.35E-01	2
METALS											
Cadmium	112.4	7.50E+01	2	0.00E+00	na	na	na	na	na	na	na
Chromium	52	1.90E+01	2	0.00E+00	na	na	na	na	na	na	na
Lead	207.2	1.22E+02	3	0.00E+00	na	na	na	na	na	na	na
Silver	107.87	8.30E+00	2	0.00E+00	na	na	na	na	na	na	na
Zinc	65.4	6.20E+01	2	0.00E+00	na	na	na	na	na	na	na

Sources:

¹ ASTM Standard E 1739-1995

² USEPA, May 1996. Soil Screening Guidance Technical Background Document. EPA/540/R-95/128.

³ These are pH-dependent Koc values experimentally derived using the regression relationship developed by USEPA's Environmental Research Laboratory, Athens, GA. March 1990.

⁴ Air Emissions Model for Waste and Wastewater, EPA-453R-94-080A, 1994 (as cited in draft Louisiana Dept. of Environmental Quality RBCA Guidance Document).

⁵ Oak Ridge National Laboratory Risk Assessment Information System.

⁶ USEPA, October 1986. Superfund Public Health Exposure Manual. EPA/540/1-86/060.

⁷Estimated from the diffusion coefficient and molecular weight for Benzo(b)fluoranthene.

REFERENCE 4

TOXICITY PARAMETERS

CHEMICAL	Oral	Slope Factor [kg-d/mg]	Reference	Inhalation	Reference	Oral	Reference	Inhalation	Reference	Dose [mg/kg-d]	Reference
ORGANICS											
Benzene	2.90E-02	1	2.90E-02	1	NA	NA	NA	NA	1.70E-03	7	
Toluene	NA	NA	NA	NA	2.00E-01	1	1.10E-01	1			
Ethylbenzene	NA	NA	NA	NA	1.00E-01	1	2.90E-01	1			
Xylenes (Total)	NA	NA	NA	NA	2.00E+00	4	8.60E-02	4			
MTBE	NA	NA	NA	NA	5.00E-03	5	8.60E-01	1			
Acenaphthene	NA	NA	NA	NA	6.00E-02	8	NA	NA			
Acenaphthylene	NA	NA	NA	NA	NA	NA	NA	NA			
Anthracene	NA	NA	NA	NA	3.00E-01	1	3.00E-01	1	3.00E-01	2	
Benzo(a)anthracene	7.30E-01	3	6.10E-01	2	NA	NA	NA	NA			
Benzo(b)fluoranthene	7.30E-01	3	6.10E-01	2	NA	NA	NA	NA			
Benzo(k)fluoranthene	7.30E-01	3	6.10E-01	2	NA	NA	NA	NA			
Benzo(a)pyrene	7.30E+00	1	6.10E+00	4	NA	NA	NA	NA			
Benzo(g,h,i)perylene	NA	NA	NA	NA	3.00E-02	9	3.00E-02	9			
Chrysene	7.30E-03	3	6.10E-03	2	NA	NA	NA	NA			
Dibenzo(a,h)anthracene	7.30E+00	8	3.10E+00	8	NA	NA	NA	NA			
EDB	8.50E+01	8	7.70E-01	8	NA	NA	NA	NA	5.71E-05	8	
EDC	9.10E-02	8	9.10E-01	8	NA	NA	NA	NA			
Fluorene	NA	NA	NA	NA	4.00E-02	1	4.00E-02	2			
Fluoranthene	NA	NA	NA	NA	4.00E-02	1	4.00E-02	2			
Indeno(1,2,3-c,d)pyrene	7.30E-01	8	3.10E-01	8	NA	NA	NA	NA			
Naphthalene	NA	NA	NA	NA	4.00E-02	7	4.00E-02	7			
Phenanthrene	NA	NA	NA	NA	3.00E-02	9	3.00E-02	9			
Pyrene	NA	NA	NA	NA	3.00E-02	1	3.00E-02	1	3.00E-02	2	
METALS											
Cadmium	NA	NA	6.30E+00	1	5.00E-04	1	NA	NA			
Chromium	NA	NA	4.20E+01	1	5.00E-03	1	5.71E-07	4			
Lead	NA	NA	NA	NA	NA	NA	NA	NA			
Silver	NA	NA	NA	NA	5.00E-03	8	NA	NA			
Zinc	NA	NA	NA	NA	3.00E-01	1	1.00E-02	6			

Sources:

- ¹ USEPA. September 1997. IRIS
- ² Route Extrapolation.
- ³ USEPA. 1992. *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* . EPA/600/R-93/089.
- ⁴ USEPA. 1991. *Health Effects Assessments Summary Tables* . OERR 9200-6-303(91-1).
- ⁵ USEPA. April 1996. Risk-Based Concentration Table, January-June 1996. USEPA Region III, Office of RCRA.
- ⁶ USEPA. October 1986. *Superfund Public Health Evaluation Manual* . EPA/540/1-86/060.
- ⁷ USEPA. Superfund Technical Support Center. Cincinnati, OH (provisional values)
- ⁸ Oak Ridge National Laboratory Risk Assessment Information System.
- ⁹ Based on pyrene surrogate RfD.

REFERENCE 5
DEFAULT EXPOSURE FACTORS

Exposure Parameter	Symbol	Units	Default Value
Averaging Time - Carcinogen	AT _c	years	70
Averaging Time - Noncarcinogen (equals exposure duration)	AT _n	years	Receptor dependent
Body Weight			
Adult Receptor	BW	kg	70
Child Receptor	BW	kg	15
Exposure Duration			
Resident Child	ED	years	6
Resident Adult	ED	years	30
Commercial Worker	ED	years	25
Construction Worker	ED	years	1
Exposure Frequency			
Residents	EF	days/yr	350
Commercial Worker	EF	days/yr	250
Construction Worker	EF	days/yr	250
Soil Ingestion Rate			
Resident Child	IR _{soil}	mg/day	200
Resident Adult	IR _{soil}	mg/day	100
Commercial Worker	IR _{soil}	mg/day	50
Construction Worker	IR _{soil}	mg/day	100
Daily Water Ingestion Rate			
Residents	IR _w	L/day	2
Hourly Indoor Inhalation Rate			
Resident Child	IR _{air} - indoor	m ³ /hr	0.417
Resident Adult	IR _{air} - indoor	m ³ /hr	0.633
Commercial Worker	IR _{air} - indoor	m ³ /hr	1.5
Construction Worker	IR _{air} - indoor	m ³ /hr	1.5
Exposure Time for Indoor Inhalation Rate			
Resident Child	ET _{in}	hr/day	24
Resident Adult	ET _{in}	hr/day	24
Commercial Worker	ET _{in}	hr/day	10
Construction Worker	ET _{in}	hr/day	10
Hourly Outdoor Inhalation Rate			
Resident Child	IR _{air} - outdoor	m ³ /hr	1
Resident Adult	IR _{air} - outdoor	m ³ /hr	1.5
Commercial Worker	IR _{air} - outdoor	m ³ /hr	1.5
Construction Worker	IR _{air} - outdoor	m ³ /hr	1.5
Exposure Time for Outdoor Inhalation Rate			
Resident Child	ET _{out}	hr/day	10
Resident Adult	ET _{out}	hr/day	10
Commercial Worker	ET _{out}	hr/day	10
Construction Worker	ET _{out}	hr/day	10

REFERENCE 5
DEFAULT EXPOSURE FACTORS

Exposure Parameter	Symbol	Units	Default Value
Soil skin adherence factor	M	mg/cm ²	0.5
Oral relative absorption factor	RAF _o		1
Dermal relative absorption factor			
Volatiles	RAF _d		0.5
PAHs	RAF _d		0.05
Metals	RAF _d		0.001
Skin surface area for dermal contract with soil			
Adults	SA	cm ² /d	5000
Children	SA	cm ² /d	2500
Target Risk			
Hazard Quotient for individual constituents/routes	THQ		1
Individual Excess Lifetime Cancer Risk for constituents/routes	TR		1x10 ⁻⁵

REFERENCE 6
RBSL DEFAULT FATE AND TRANSPORT PARAMETERS

PARAMETER	SYMBOL	UNITS	DEFAULT VALUE
Lower depth of surficial soil zone	d	cm	30.48
Depth to groundwater	L _{gw}	cm	300
Depth to subsurface soil sources	L _s	cm	30.48
Dry soil bulk density	ρ _s	g/cm ³	1.8
Volumetric water content in vadose zone soils	θ _{ws}	cm ³ /cm ³	0.1
Volumetric water content in capillary fringe soils	θ _{wcap}	cm ³ /cm ³	0.26
Volumetric water content in foundation/wall cracks	θ _{wcrack}	cm ³ /cm ³	0.1
Volumetric air content in vadose zone soils	θ _{as}	cm ³ /cm ³	0.2
Volumetric air content in capillary fringe soils	θ _{acap}	cm ³ /cm ³	0.04
Volumetric air content of foundation/wall cracks	θ _{acrack}	cm ³ /cm ³	0.2
Fractional organic carbon content in soil	f _{oc}	g-C/g-soil	0.01
Infiltration rate of water through soil	I	cm/yr	15.2
Width of source area parallel to wind, or ground water flow direction	S _w	cm	1500
Thickness of capillary fringe	h _{cap}	cm	5
Thickness of vadose zone	h _v	cm	295
Wind speed within the breathing zone	U _a	cm/s	225
Breathing zone height	δ _a	cm	200
Area fraction of cracks in foundation or walls	η	cm ² /cm ²	0.01
Total soil porosity	θ _T	cm ³ /cm ³ -soil	0.3
Enclosed space foundation or wall thickness	L _{crack}	cm	15
Enclosed space air exchange rate			
Resident	ER	l/s	0.00014
Commercial/Construction Worker	ER	l/s	0.00023
Enclosed space volume/infiltration area ratio			
Resident	L _B	cm	200
Commercial/Construction Worker	L _B	cm	300
Particulate emission rate			
Resident/Commercial	P _e	g/cm ² -s	6.90E-14
Construction Worker	P _e	g/cm ² -s	6.90E-09
Averaging time for Vapor Flux			
Resident Adult	τ	sec	9.46E+08
Resident Child	τ	sec	1.89E+08
Commercial Worker	τ	sec	7.88E+08
Construction Worker	τ	sec	3.15E+07

Source: ASTM Standard: E 1739-95 Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites